Chemistry 988

Spring, 2oo9   Problem Set #3

Distributed: Thurs., 19 Mar. o9   Due: Thurs., 2 Apr. o9

1. Many silicon semiconductor detectors in use at the NSCL were manufactured by MI-CRON Semiconductor Corp. in England. A typical recently purchased PIN device is MSX25-500 that has an area of 50x50 mm^2 and a thickness of 517μm. The operating bias is 90 volts for full depletion. The contact layers are $\sim$0.5 μm each and thus can be ignored. Make an estimate of the resistivity of this material if it is n-type silicon.

2. A "4 Megapixel" chip in a modern digital camera is based on a chip with 2240x1680 pixels and the data can be clocked out at 30 MHz. (1) How long does it take to record a single image if the device is readout through a single Analogue to digital convertor (ADC)? (2) How many green photons (430 nm) must be absorbed by the silicon in one pixel if the ADC has a threshold of 20 electrons.

3. What is the ratio of the mean number of photons created in a standard 3"x3" NaI(Tl) detector by the photopeak of the ^{40}K decay to that created by the average cosmic ray interaction?

4. Since uranium is an impurity in most metals, a gas-filled detector will have a low-level background from alpha particles that are emitted from uranium and its daughter nuclei that leave the wall and enter the gas. A typical level of contamination is 20 parts-per-billion. Estimate the counting rate of alpha particles per square centimeter per second leaving the surface. Note that the most important alpha particle will come from ^{235}U decay and assume that one-half of the alpha particles exit the surface from a layer that is equal to the 1/2 the range of the alpha particle.